VOLUME - 13, ISSUE - 01, JANUARY - 2024 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Forensic Medicine

PATTERN OF SKULL FRACTURES IN ROAD TRAFFIC ACCIDENTS: AN AUTOPSY BASED STUDY

Dr. Arjun S Pillai — Assistant Professor of Forensic Medicine, P K DAS Institute of Medical Sciences

Dr. Nivin George* — Associate Professor of Forensic Medicine, P K DAS Institute of Medical Sciences *Corresponding Author

ABSTRACT

Introduction: The head, comprising the cranium and face, houses vital organs such as the brain and sense organs. Understanding the intricate anatomy of the skull, divided into regions, is essential for studying skull fractures. The skull's protective functions, distinctive features of its bones, and developmental aspects are crucial for interpreting fractures. **Objective(s):** This study aims to investigate the patterns of skull fractures in fatal road traffic accidents (RTAs), focusing on mechanisms, types, and demographics. Understanding these patterns is vital for effective emergency responses and preventive measures. **Methods:** Autopsy-based data were collected over 1.5 years from 100 RTA victims with documented skull fractures. The study utilized police documents, magnifying lenses, cameras, and a structured pro forma for autopsy. Inclusion criteria covered all age groups, excluding unknown and mutilated bodies, pathologies, railway mishaps, operated cases, and falls from height. **Results:** Fissured fractures (39%) predominated, with temporal bones frequently involved. Males constituted 78% of cases, and the 61-70 age group showed the highest prevalence. Pedestrians accounted for 53% of cases. **Discussion:** Consistent with previous studies, fissured fractures were common, and males were more affected. Temporal bones were notably involved, aligning with existing literature. Comparisons with studies by Dr. Sunil Kumar Soni and others revealed consistency in findings. **Conclusion:** The study provides valuable insights into skull fracture patterns in fatal RTAs. Fissured fractures, particularly in the temporal bone, were predominant. Gender disparity and a higher prevalence of fractures in pedestrians underscore the need for targeted preventive measures.

KEYWORDS : Skull Fractures; Road Traffic Accidents; Autopsy; Preventive Measures; Emergency Response; Gender Disparity; Temporal Bones; Fissured Fractures.

INTRODUCTION

Head Anatomy:

The head, the cranial end of the body housing the brain and special sense organs, is divided into two parts: the cranium and the face. The cranium, housing the brain, has seen proportional enlargement to accommodate the well-developed human brain, resulting in a prominent forehead. The face, home to the eyes, nose, and mouth openings, exhibits unique features, including a distinctive external nose and a prominent chin. The head is further divided into regions such as frontal, parietal, occipital, temporal, auricular, parotid, orbital, nasal, zygomatic, buccal, oral, and mental. Each region carries specific anatomical characteristics.

Osteology of the Head – Skull [1]:

The skull, comprising 22 bones excluding ear ossicles, is divided into cranial and facial skeletons. The cranial skeleton, providing rigid protection to the brain, consists of eight bones, including paired parietal and temporal bones.[3]The facial skeleton, relatively fragile and light, encompasses fourteen bones, including the maxilla, zygomatic, and nasal bones. [4] [7]Sutures, immovable joints, connect skull bones, except for the mandible, which forms freely movable temporo mandibular joints. Various anatomical positions, such as norma verticalis, occipitalis, frontalis, lateralis, and basalis, reveal external features of the skull from different aspects.[5][6]

Functions of the Skull [1]:

The skull serves essential functions in the human body, playing a crucial role in safeguarding the brain and meninges from external trauma. [2] Beyond protection, it accommodates special sense organs, providing structural support for the eyes, ears, and nose. Additionally, the skull contributes to the respiratory and digestive systems by providing openings for air and food passage. Furthermore, it serves as the anatomical framework for housing teeth and jaws, facilitating the process of mastication.

Distinctive Features of Skull Bones:

Distinctive characteristics of skull bones highlight their unique developmental processes. Firstly, the base of the skull undergoes cartilaginous ossification, while the skull cap undergoes membranous ossification, revealing the diverse nature of bone formation within the skull. Secondly, the skull consists of a single table at birth, evolving into two tables by the age of 4, with diploe containing red bone marrow, showcasing the dynamic changes in bone structure during early development.[8]Thirdly, fontanelles, present at the four angles of the parietal bone at birth, play a vital role in aiding skull bone overlapping during the delivery process. Lastly, certain bones, such as the frontal and maxilla, possess pneumatic qualities, contributing to voice resonance and potentially leading to the development of sinusitis, underscoring the intricate and multifaceted nature of skull anatomy.

Embryology of Skull Bones:

Mesenchyme surrounding the developing brain interacts with occipital somites, otic and nasal capsules, and the first branchial arch to contribute to skull development. Some bones form in membrane (e.g., frontal, parietal), some in cartilage (e.g., ethmoid), and others through a combination of membrane and cartilage (e.g., occipital, sphenoid).

Differences between male and female skulls and mandibles[9] [10][11]

Generally, male skulls exhibit larger and heavier dimensions compared to their female counterparts, evident in overall size and specific characteristics. Male foreheads tend to be more prominent and slope backward, whereas female foreheads are typically smoother and more vertical. Brow ridges in males are more pronounced than in females. The mandible, or lower jaw, is often larger and more robust in males, while females typically have smaller and more delicate mandibles. The mastoid process, a bony prominence behind the ear, is generally larger in males. Additionally, the mandibular angle in males is often squarer and more prominent, whereas females tend to have a smoother, more rounded mandibular angle. Male orbital openings are typically larger and more rounded, contrasting with the smaller and more oval-shaped openings in females. Furthermore, male teeth are generally larger and may show more wear due to differences in diet and chewing patterns. These distinctions collectively contribute to the identification and differentiation of male and female skulls and mandibles, providing valuable insights in forensic anthropology and anatomical studies.

Mechanism of Skull Fractures[12] [13]

The mechanism of skull fractures is intricate and involves both direct and indirect causes. Direct injuries may occur through compression, such as during childbirth or the crushing force of a vehicle wheel, as well as impacts from moving objects like bullets, bricks, and machinery. Repeated jarring to the head from sharp blows, falls, and traffic incidents further contribute to the risk of skull fractures. Understanding the average thickness of various skull bones is crucial, with the occipital bone being the thickest and the temporal bone the thinnest.

Hypotheses on Skull Fractures[14][15][18][19][20][21][22]

Two key hypotheses, Rowbotham's and Gurdjian et al's, provide insights into the nature of skull fractures. Rowbotham proposes that fractures can result from either direct force or general deformation, emphasizing the significance of elasticity limits. Gurdjian et al focus on energy absorption, considering factors such as velocity, object characteristics, skull thickness, and the presence of scalp hair. [16] Skull fractures pose diverse dangers, including meningeal and brain injuries, laceration by bone fragments, and the potential for post-traumatic epilepsy.[17]

Types of Skull Fractures[23][24][25][26][27]

Skull fractures manifest in various types, each associated with specific causes and characteristics. Comminuted fractures involve multiple fragments, depressed fractures result from high kinetic energy objects, and fissured fractures occur due to general deformation. Pond fractures create a dent, gutter fractures form a bone gutter, and ring fractures encircle the skull. [28] Penetrating and perforating fractures involve entry and exit points, diastatic fractures separate sutures, and basal fractures are categorized into anterior, middle, and posterior types. [29]Blowout fractures affect the eye socket, expressed fractures involve massive fragmentation, and vulnerable road users, such as pedestrians and cyclists, face an increased risk of skull fractures in road accidents.[30]

Understanding the mechanisms, types, and patterns of skull fractures is paramount for formulating effective emergency responses and preventive measures, particularly in the context of road traffic accidents. [31] This knowledge underscores the importance of prompt treatment, adherence to traffic rules, and the use of protective gear to mitigate the morbidity and mortality associated with head injuries.[32]

METHODS

The study draws its subjects from autopsy cases of RTA victims at the Department of Forensic Medicine, Government Medical College, Thrissur. The research duration spans one and a half years, adhering to ethical guidelines. Autopsy samples, obtained through consecutive sampling, include 100 cases with documented skull fractures. The methodology involves utilizing the Kerala Police Form, relevant police documents, a magnifying lens, a camera, and a structured pro forma for autopsy.

Inclusion and Exclusion Criteria:

The inclusion criteria encompass autopsy samples with a known or alleged history of death due to RTAs, covering all age groups. Exclusion criteria eliminate unknown and mutilated bodies, cases with pathologies affecting the musculoskeletal system, railway mishaps, operated cases, and falls from height.

Sample Size Calculation:

The study's sample size is determined using the formula $n=4pq/d^2$, with a calculated sample size of 100 based on a similar previous study. The decision to conduct the study on 100 samples aims to ensure a robust dataset.

Data Collection:

Data collection involves a meticulous examination of the Kerala Police form and relevant documents brought by the police. The autopsy process utilizes magnifying lenses and cameras to document fractures. A detailed post-mortem examination is conducted, and a questionnaire captures critical information, including the victim's name, age, gender, and the type of skull fracture.

Analysis

Data analysis is conducted using MS Excel, and statistical analyses are performed using R software (Version 3.53). Types of fractures and the bones involved are tabulated, and proportions are calculated. Gender predominance is determined, and age is summarized in class intervals.

RESULTS

During the study period, 100 consecutive cases of RTAs with skull fractures were analyzed. Fissured fractures were the most prevalent (39%), followed by comminuted fractures. Temporal bones were the most commonly involved in cranial fractures, with the mandible being the most affected facial bone. Males constituted 78% of the cases, emphasizing gender predominance. The age distribution highlighted a prevalence of victims in the 61-70 age group. Pedestrians were most commonly involved in RTAs, comprising 53% of the cases.

DISCUSSION

Comparisons with similar studies, such as one conducted by Dr. Sunil Kumar Soni, Dr. Sanjay K. Dadu, Dr. Bajrang Singh, reveal consistency in findings. Fissured fractures were commonly observed, and males were more frequently affected than females. Temporal bones were notably involved, aligning with the observations made by Gupta et al. Additionally, the prevalence of fractures in pedestrians mirrors the findings of Ahmad M, Rahman F N, Chowdhury MH, Islam AKMS, Hakim MA.

CONCLUSION

The study provides valuable insights into the patterns of skull fractures in fatal RTAs. Fissured fractures, particularly in the temporal bone, emerge as predominant. The gender disparity, with males being more affected, and the prevalence of fractures in pedestrians underscore the need for targeted preventive measures.

Recommendations

1. Helmet and Seatbelt Emphasis: Public awareness campaigns highlighting the importance of wearing helmets for two-wheeler riders and seatbelts for vehicle occupants should be intensified. Properly designed helmets significantly reduce the risk of head injuries.
2. Traffic Rules Adherence: Both the government and the public should prioritize adhering to traffic rules and regulations. Measures to enforce speed limits, prevent drunk driving, and promote responsible driving behavior are crucial.
3. Ambulance Services: Timely and efficient ambulance services are imperative for reducing mortality. Government and voluntary agencies should collaborate to ensure prompt medical attention for RTA victims.
4. Infrastructure Planning: Government initiatives should focus on planning safe and efficient transport systems that accommodate diverse road users. Designing roadways with pedestrian safety in mind can contribute to reducing accidents.

Limitations The study acknowledges the influence of traffic patterns on fatalities, emphasizing the need for a context-specific approach to road safety. Additionally, the study underscores the economic burden of RTAs and the importance of sustained efforts to address this public health challenge.

Conflict of Interest Statement
No conflict of interest to be declared.

Source of Funding
Expenses met by the investigators.

Ethical issues
All ethical formalities adhered to. Confidentiality of the data was maintained.

Glossary of Abbreviations
- RTA: Road Traffic Accident
- MS: Microsoft
- DNA: Deoxyribonucleic Acid
- MS Excel: Microsoft Excel
- RTAs: Road Traffic Accidents
- MRI: Magnetic Resonance Imaging
- RH: Right Hemisphere
- LH: Left Hemisphere
- IT: Information Technology

Figure 1: Fissured fracture

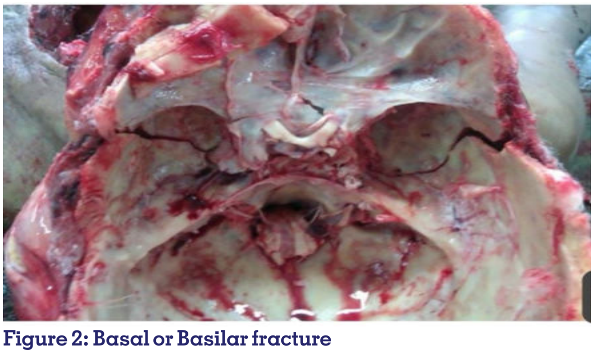

Figure 2: Basal or Basilar fracture

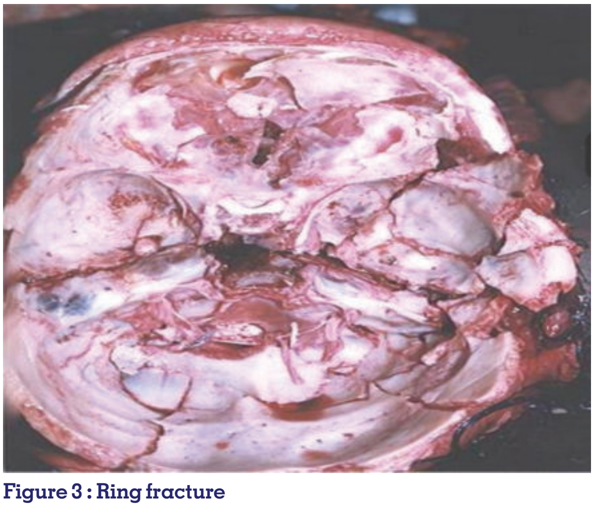

Figure 3 : Ring fracture

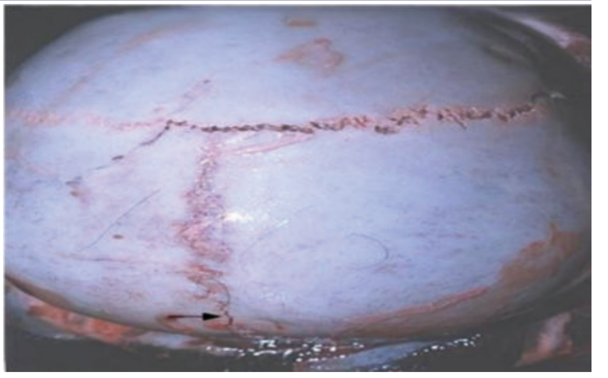

Figure 4: Diastatic fracture

REFERENCES
1. Vishram Singh. Textbook of Anatomy – Head, Neck and Brain, Volume III, Third edition: Elsevier publications. 2018:13-22
2. R J Last. Anatomy, Regional and Applied, sixth edition: Churchill Livingstone, 1978 reprinted in 1981:553
3. B D Chaurasia's Human Anatomy, Regional and Applied Dissection and Clinical, Volume 3, Head and Neck, Brain, Fifth edition: CBS Publishers and Distributors Pvt Ltd. 2010: 3
4. R J Last. Anatomy, Regional and Applied, sixth edition: Churchill Livingstone, 1978 reprinted in 1981:555
5. Vishram Singh. Textbook of Anatomy – Head, Neck and Brain, Volume III, Third edition: Elsevier publications. 2018:26-42 54
6. R J Las. Anatomy, Regional and Applied, sixth edition: Churchill Livingstone, 1978 reprinted in 1981:562
7. B D Chaurasia's Human Anatomy, Regional and Applied Dissection and Clinical, Volume 3, Head and Neck, Brain, Fifth edition: CBS Publishers and Distributors Pvt Ltd. 2010: 4
8. Inderbir Singh, G P Pal. Human Embryology, Seventh Edition: Macmillan India Ltd.2001 reprinted 2005:130-131
9. Dr. K. S. Narayan Reddy and Dr. O.P. Murthy. The Essentials of Forensic Medicine & Toxicology, 34th edition: Jaypee Brothers Medical Publishers Ltd. 2017:59-60
10. Dr. P. C. Ignatius. Forensic Medicine and Toxicology, 3rd Edition: Letterwave Books Publishers 2018:72
11. Dr. P. C. Ignatius. Forensic Medicine and Toxicology, 3rd Edition: LetterwaveBooks Publishers 2018:73
12. Cyril John Polson, D.J. Gee and Bernard Knight. The Essentials of ForensicMedicine, Fourth edition: Pergamon Press 1985: 150-151
13. Professor Pekka Saukko, Professor Bernard Knight. Knight's Forensic Pathology,Fourth edition: CRC Press 2016: 174-175
14. Moritz A.R. The Pathology of Trauma, Philadelphia: Lee and Febiger.1942: 327
15. I. Gordon, H.A. Shapiro, S.D. Berso. Forensic Medicine, A Guide to Principles,Third edition: Churchill Livingstone 1988: 255
16. Rowbotham G.F. Acute Injuries of Head, Fourth edition Edinburgh: Livingstone1964: 60-62
17. I. Gordon, H.A. Shapiro, S.D. Berson. Forensic Medicine, A Guide to rinciples,Third edition: Churchill Livingstone 1988:254-256
18. I. Gordon, H.A. Shapiro, S.D. Berson. Forensic Medicine, A Guide to Principles, Third edition: Churchill Livingstone 1988:258
19. Blackwood W, McMenemy W H, Meyer a, Norman R.M. Greenfield's Neuropathology London: Arnold 2nd edition 1963: 443
20. Gurdjian E S, Webster J E, Lissner H R. The Mechanism of Skull Fracture. J Neurosurgery 1950;7: 106-114
21. I. Gordon, H.A. Shapiro, S.D. Berson. Forensic Medicine, A Guide to Principles, third edition: Churchill Livingstone 1988: 259-266
22. Professor Pekka Saukko, Professor Bernard Knight. Knight's Forensic Pathology, Fourth edition: CRC Press 2016: 181
23. Anil Aggrawal. Textbook of Forensic Medicine and Toxicology, First Edition: Avichal Publishing Company 2014 reprinted in 2017: 327-330
24. Dr. K. S. Narayan Reddy and Dr. O.P. Murthy. The Essentials of Forensic Medicine & Toxicology, 34th edition: Jaypee Brothers Medical Publishers Ltd. 2017: 229- 232
25. Dr. P. C. Ignatius. Forensic Medicine and Toxicology, Second Edition: Letterwave Books Publishers 2017: 161
26. Cyril John Polson, D.J. Gee and Bernard Knight. The Essentials of Forensic Medicine, Fourth edition: Pergamon Press 1985: 161
27. Dr. P. C. Ignatius. Forensic Medicine and Toxicology, Second Edition: Letterwave Books Publishers 2017: 162
28. Dr. P. C. Ignatius. Forensic Medicine and Toxicology, Second Edition: Letterwave Books Publishers 2017: 163
29. Edirisinghe P A S, Kituwatte I D G, Senarathne U D. Injuries in Vulnerable Road User Fatalities; A Study from Sri Lanka. J Forensic Leg Med. October 2014; 27: 9- 12
30. World Health Organisation[internet]. Pedestrian safety: a road safety manual for decision makers and practitioners, Geneva: World Health Organisation; 2013 [cited2014 Feb] available from: http://www.who.int/iris/bitstream/10665/79753/1/9789241505352_eng.pdf
31. Dr. Sunil Kumar Soni, Dr. Sanjay K. Dadu, Dr. Bajrang K Singh. Pattern of Skull Fracture in Fatal Road Traffic Accident Victims: An Autopsy Based Study. Scholars Journal of Applied Medical Sciences. 2016 May; 4(5F):1819-1822
32. Tandle RM, Keoliya AN. Patterns of Head Injuries in Fatal Road Traffic Accidents in a Rural District of Maharashtra – Autopsy Based Study. Journal of Indian Academy of Forensic Medicine. 2011 July to September; 33(3):228-31